Features

- **Can be used as either 1 off 512k x 32, 2 off 512k x 16 or 4 off 512k x 8**
- **Operating Voltage: 3.3V $\pm$ 0.3V**
- **Access Time:**
  - **AT68166FT (5V Tolerant)**
    - **. 25 ns (preliminary information)**
    - **. 17 ns (advanced information)**
  - **AT68166F**
    - **. 15 ns (advanced information)**
- **Very Low Power Consumption**
  - **AT68166FT (5V Tolerant)**
    - **. Active: 540 mW per byte (Max) @ 25 ns - 450 mW per byte (Max) @ 50ns**
    - **. Standby: 15 mW (Typ)**
  - **AT68166F**
    - **. Active: 650 mW per byte (Max) @ 15 ns - 540 mW per byte (Max) @ 25ns**
    - **. Standby: 15 mW (Typ)**
- **Military Temperature Range: -55 to +125°C**
- **TTL-Compatible Inputs and Outputs**
- **Asynchronous**
- **Die manufactured on Atmel 0.25 µm Radiation Hardened Process**
- **No Single Event Latch Up below LET Threshold of 80 MeV/mg/cm^2**
- **Tested up to a Total Dose of 300 krads (Si) according to MIL-STD-883 Method 1019**
- **ESD Better than 4000V for the AT68166F**
- **ESD Better than 2000V for the AT68166FT**
- **Quality Grades: ESCC, QML-Q or V**
- **950 Mils Wide MQFPT 68 Package**
- **Mass : 8.5 grams**

Description

The AT68166F/FT is a 16Mbit Radiation Hardened hermetic Multi Chip Module (MCM), made of very low-power CMOS asynchronous static RAM which can be organized as 1 bank off 512K x 32, 2 banks off 512Kx16, or 4 banks off 512Kx8. It is built with 4 dies of the AT60142F/FT SRAM keeping all their basic characteristics: power consumption, stand by current, data retention, Multiple Bit Upset (MBU) immunity, etc…

This MCM takes full benefit of Atmel expertise in hermetic ceramic package assembly. The small size of the AT60142F/FT die allows for assembling it in a 68 pins quad flat pack which results into a package footprint compatible with products from other sources. Furthermore, all dies being assembled on the same package side makes power dissipation through the PCB much easier and more efficient.

This MCM brings the solution to applications where fast computing is as mandatory as low power consumption and higher integration density, saving 75% of the PCB area used when using the individually packaged 4MB SRAM.

The AT68166FT is biased at 3.3V and allows for 5V tolerance. It is available in 25 ns and 17 ns specification.

The AT68166F is biased at 3.3V and is not 5V tolerant. It is available in 15 ns specification.

The AT68166F/FT will be processed according to the test methods of the latest revision of the MIL-PRF-38535 or the ESCC 9000.

Rad Hard 16 MegaBit SRAM Multi Chip Module

AT68166F
AT68166FT

Preliminary

7531C–AERO–04/06

Block Diagram

Figure 1. AT68166F/FT Block Diagram

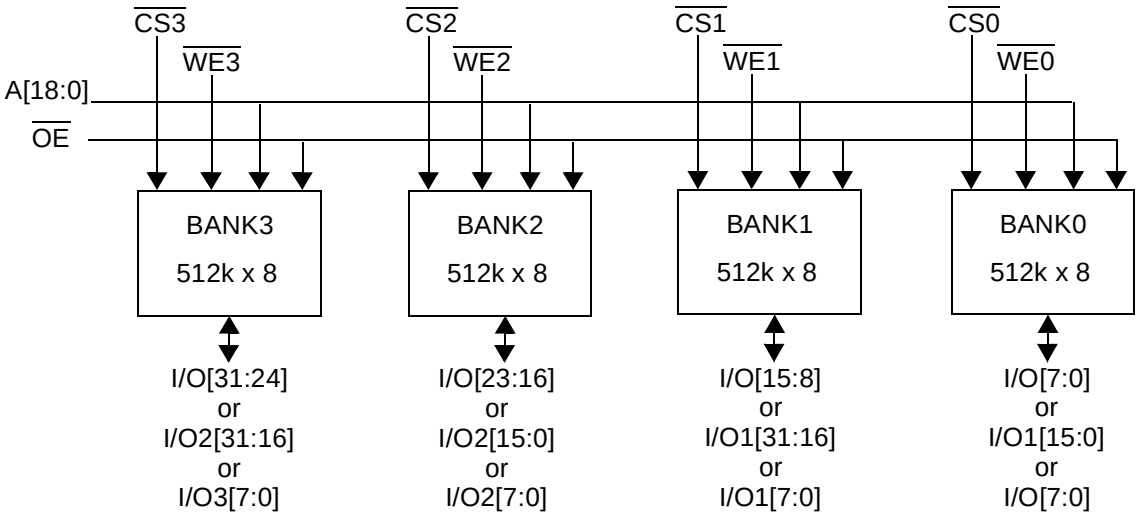
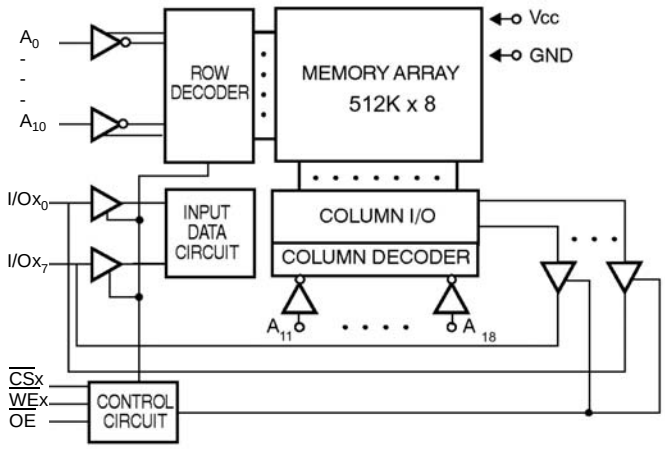


Figure 2. 512K x 8 Banks Block Diagram (AT60142F/FT)

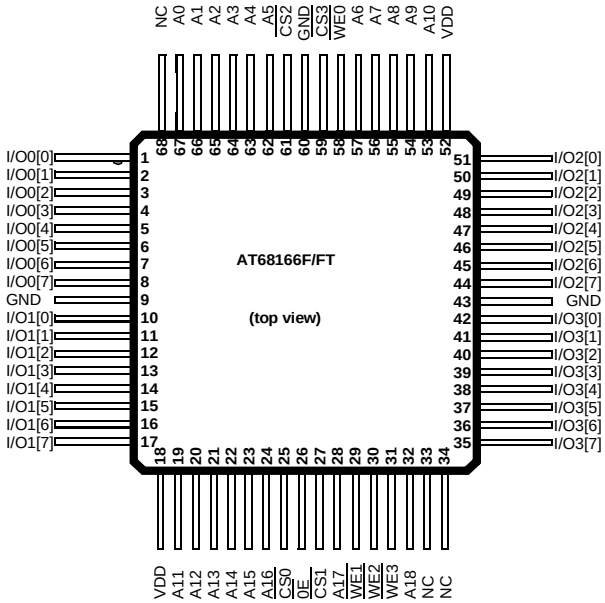


Pin Configuration

Table 1. AT68166F/FT pin assignement

Lead	Signal	Lead	Signal	Lead	Signal	Lead	Signal
1	I/O0[0]	18	VDD	35	I/O3[7]	52	VDD
2	I/O0[1]	19	A11	36	I/O3[6]	53	A10
3	I/O0[2]	20	A12	37	I/O3[5]	54	A9
4	I/O0[3]	21	A13	38	I/O3[4]	55	A8
5	I/O0[4]	22	A14	39	I/O3[3]	56	A7
6	I/O0[5]	23	A15	40	I/O3[2]	57	A6
7	I/O0[6]	24	A16	41	I/O3[1]	58	$\overline{WE0}$
8	I/O0[7]	25	$\overline{CS0}$	42	I/O3[0]	59	$\overline{CS3}$
9	GND	26	$\overline{OE}$	43	GND	60	GND
10	I/O1[0]	27	$\overline{CS1}$	44	I/O2[7]	61	$\overline{CS2}$
11	I/O1[1]	28	A17	45	I/O2[6]	62	A5
12	I/O1[2]	29	$\overline{WE1}$	46	I/O2[5]	63	A4
13	I/O1[3]	30	$\overline{WE2}$	47	I/O2[4]	64	A3
14	I/O1[4]	31	$\overline{WE3}$	48	I/O2[3]	65	A2
15	I/O1[5]	32	A18	49	I/O2[2]	66	A1
16	I/O1[6]	33	NC	50	I/O2[1]	67	A0
17	I/O1[7]	34	NC	51	I/O2[0]	68	NC

Figure 3. AT68166F/FT pin assignement



Pin Description

Table 2. Pin Names

Name	Description
A0 - A18	Address Inputs
I/O0 - I/O31	Data Input/Output
$\overline{CS0}$ - $\overline{CS3}$	Chip Select
$\overline{WE0}$ - $\overline{WE3}$	Write Enable
$\overline{OE}$	Output Enable
VCC	Power Supply
GND[1]	Ground

Note: 1. The package lid is connected to GND

Table 3. Truth Table[1]

$\overline{CSx}$	$\overline{WEx}$	$\overline{OE}$	Inputs/Outputs	Mode
H	X	X	Z	Standby
L	H	L	Data Out	Read
L	L	X	Data In	Write
L	H	H	Z	Output Disable

Note: 1. L=low, H=high, X= H or H, Z=high impedance.

Electrical Characteristics

Absolute Maximum Ratings*

Supply Voltage to GND Potential:	-0.5V + 4.6V
DC Input Voltage:	GND -0.5V to 4.6V(1)
DC Output Voltage High Z State:	GND -0.5V to 4.6V
Storage Temperature:	-65°C to + 150°C
Output Current Into Outputs (Low):	20 mA
Electro Statics Discharge Voltage(2):	> 4000V (MIL STD 883D Method 3015.3)

*NOTE: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note: 1. 7V for FT version.
2. For AT68166F. It is better than 2000V for AT68166FT.

Military Operating Range

Operating Voltage	Operating Temperature
3.3 $\pm$ 0.3V	-55°C to + 125°C

Recommended DC Operating Conditions

Parameter	Description	Min	Typ	Max	Unit
Vcc	Supply voltage	3	3.3	3.6	V
GND	Ground	0.0	0.0	0.0	V
V_{IL}	Input low voltage	GND - 0.3	0.0	0.8	V
V_{IH}	Input high voltage	2.2	–	V_{CC} + 0.3(1)	V

Note: 1. FT version: 5.5V in DC, 5.8V in transient conditions.

Capacitance

Parameter	Description	Min	Typ	Max	Unit
C_{in}(1) (OE and Ax)	Input capacitance	–	–	48	pF
C_{in}(1) (CSx and WEx)	Input capacitance	–	–	12	pF
C_{io}(1)	I/O capacitance	–	–	12	pF

Note: 1. Guaranteed but not tested.

DC Parameters

Parameter	Description	Minimum	Typical	Maximum	Unit
$IIX^{(1)}$	Input leakage current	-1	–	1	µA
$IOZ^{(1)}$	Output leakage current	-1	–	1	µA
$IIH^{(2)}$ at 5.5V	Input Leakage Current ($\overline{OE}$ & Axx)	-	–	10	µA
	Input Leakage Current ($\overline{WE}$ & $\overline{CS}$)	-	-	5	µA
$IOZH^{(2)}$ at 5.5V	Output Leakage Current	-	–	5	µA
$VOL^{(3)}$	Output low voltage	–	–	0.4	V
$VOH^{(4)}$	Output high voltage	2.4	–	–	V

Notes: 1. $GND < V_{IN} < V_{CC}$, $GND < V_{OUT} < V_{CC}$ Output Disabled.
2. FT version only: $V_{IN} = 5.5V$, $V_{OUT} = 5.5V$, Output Disabled.
3. V_{CC} min. $I_{OL} = 8$ mA (F version) - $I_{OL} = 6$ mA (FT version)
4. 4. V_{CC} min. $I_{OH} = -4$ mA

Consumption

Symbol	Description	TAVAV/TAVAW Test Condition	AT68166FT-25 (preliminary)	AT68166FT-17 (advanced)	AT68166F-15 (advanced)	Unit	Value
$I_{CCSB}^{(1)}$	Standby Supply Current	–	10	10	10	mA	max
$I_{CCSB1}^{(2)}$	Standby Supply Current	–	8	8	8	mA	max
$I_{CCOP}^{(3)}$ Read per byte	Dynamic Operating Current	15 ns 17 ns 25 ns 50 ns 1 µs	- - 150 85 15	- 170 150 85 15	180 - 150 85 15	mA	max
$I_{CCOP}^{(4)}$ Write per byte	Dynamic Operating Current	15 ns 17 ns 25 ns 50 ns 1 µs	- - 150 125 110	- 155 150 125 110	160 - 150 125 110	mA	max

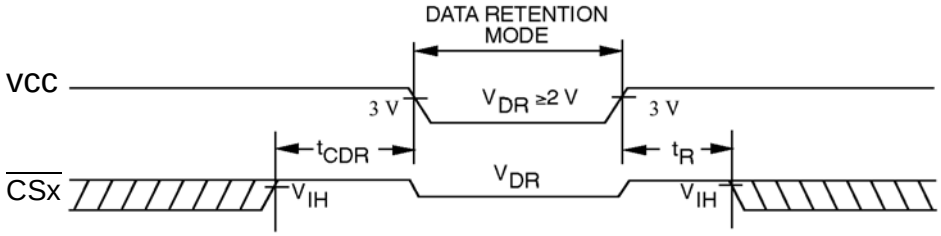
Notes: 1. All $\overline{CSx} \geq V_{IH}$
2. All $\overline{CSx} \geq V_{CC} - 0.3V$
3. $F = 1/_{TAVAV}$, $I_{out} = 0$ mA, $\overline{WEx} = \overline{OE} = V_{IH}$, $V_{IN} = GND/V_{CC}$, V_{CC} max.
4. $F = 1/_{TAVAW}$, $I_{out} = 0$ mA, $\overline{WE}x = V_{IL}$, $\overline{OE} = V_{IH}$, $V_{IN} = GND/V_{CC}$, V_{CC} max.

Data Retention Mode

Atmel CMOS RAM's are designed with battery backup in mind. Data retention voltage and supply current are guaranteed over temperature. The following rules insure data retention:

1. During data retention chip select $\overline{CSx}$ must be held high within V_{CC} to V_{CC} -0.2V.
2. Output Enable ($\overline{OE}$) should be held high to keep the RAM outputs high impedance, minimizing power dissipation.
3. During power-up and power-down transitions $\overline{CSx}$ and $\overline{OE}$ must be kept between V_{CC} + 0.3V and 70% of V_{CC}.
4. The RAM can begin operation > t_R ns after V_{CC} reaches the minimum operation voltages (3V).

Figure 4. Data Retention Timing



Data Retention Characteristics

Parameter	Description	Min	Typ T_A = 25°C	Max	Unit
V_{CCDR}	V_{CC} for data retention	2.0	–	–	V
t_{CDR}	Chip deselect to data retention time	0.0	–	–	ns
t_R	Operation recovery time	t_{AVAV} (1)	–	–	ns
I_{CCDR} (2)	Data retention current	–	3	6	mA

1. T_{AVAV} = Read cycle time.
2. All $\overline{CSx}$ = V_{CC}, V_{IN} = GND/V_{CC}.

AC Characteristics

Temperature Range:..... -55 +125°C

Supply Voltage: ..... 3.3 ±0.3V

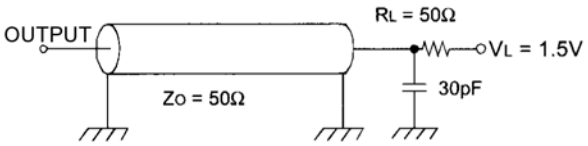
Input Pulse Levels:..... GND to 3.0V

Input Rise and Fall Times:..... 3ns (10 - 90%)

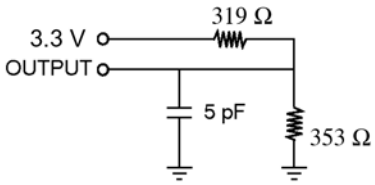
Input and Output Timing Reference Levels:..... 1.5V

Output Loading I_{OL}/I_{OH}:..... See Figure 3

Figure 5. AC Test Loads Waveforms



General



Specific (TWLQZ, TWHQX, TELQX, TEHQZ TGLQX, TGHQZ)

Write Cycle

Table 4. Write cycle timings(2)

Symbol	Parameter	AT68166FT-25 (preliminary)		AT68166FT-17 (advanced)		AT68166F-15 (advanced)		Unit
		min	max	min	max	min	max	
TAVAW	Write cycle time	20	-	17	-	15	-	ns
TAVWL	Address set-up time	2	-	0	-	0	-	ns
TAVWH	Address valid to end of write	14	-	8	-	8	-	ns
TDVWH	Data set-up time	9	-	7	-	7	-	ns
TELWH	$\overline{CS}$ low to write end	12	-	12	-	12	-	ns
TWLQZ	Write low to high Z(1)	-	10	-	7	-	6	ns
TWLWH	Write pulse width	12	-	8	-	8	-	ns
TWHAX	Address hold from end of write	0	-	0	-	0	-	ns
TWHDX	Data hold time	2	-	0	-	0	-	ns
TWHQX	Write high to low Z(1)	5	-	3	-	3	-	ns

Notes: 1. Parameters guaranteed, not tested, with output loading 5 pF. (See “AC Test Loads Waveforms” on page 8.)
2. Timings figures applicable for 8-bit, 16-bit and 32-bit mode.

Figure 6. Write Cycle 1. $\overline{WE}$ Controlled, $\overline{OE}$ High During Write

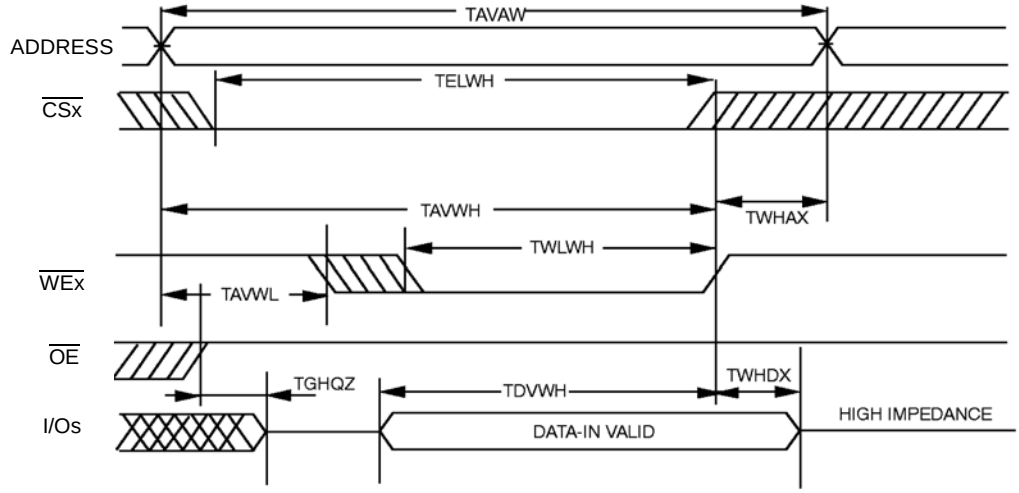


Figure 7. Write Cycle 2. $\overline{WE}$ Controlled, $\overline{OE}$ Low

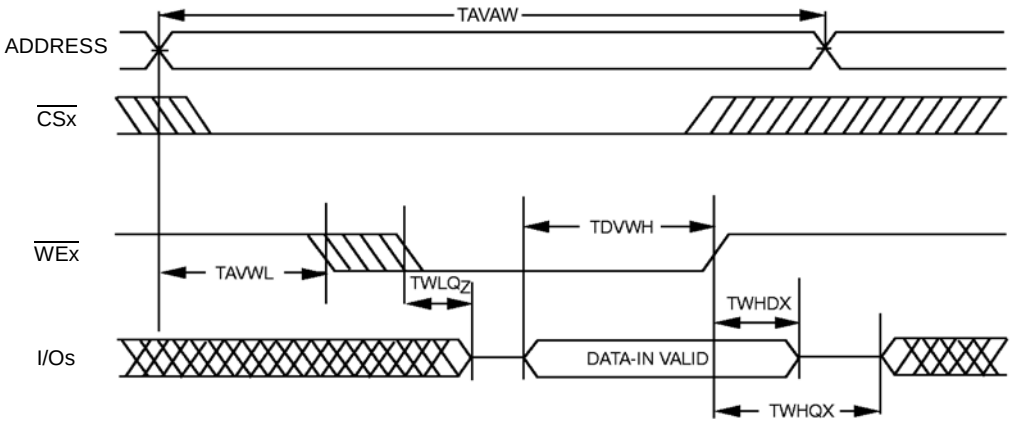
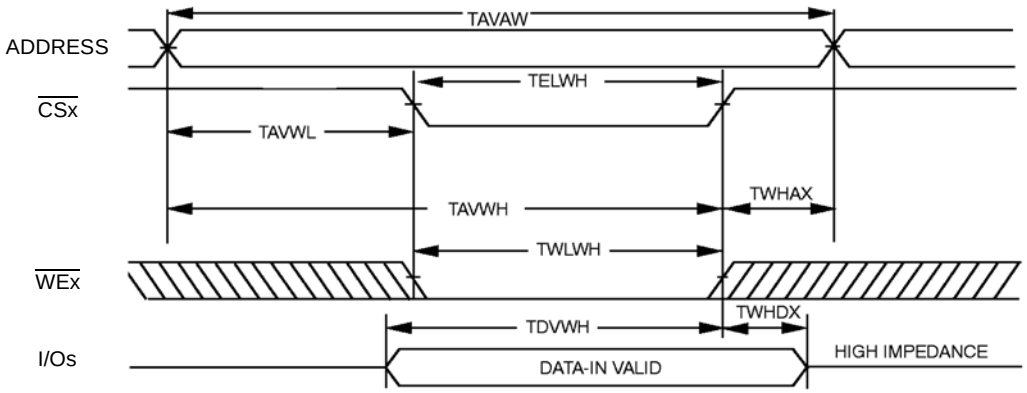


Figure 8. Write Cycle 3. $\overline{CS}$ Controlled[1]



The internal write time of the memory is defined by the overlap of $\overline{CS}$ Low and $\overline{WE}$ LOW. Both signals must be activated to initiate a write and either signal can terminate a write by going in active mode. The data input setup and hold timing should be referenced to the active edge of the signal that terminates the write. Data out is high impedance if $\overline{OE}$= V_{IH}.

Read Cycle

Table 5. Read cycle timings(2)

Symbol	Parameter	AT68166FT-25 (preliminary)		AT68166FT-17 (advanced)		AT68166F-15 (advanced)		Unit
		min	max	min	max	min	max	
TAVAV	Read cycle time	25		17		15		ns
TAVQV	Address access time		25		17		15	ns
TAVQX	Address valid to low Z	5		5		5		ns
TELQV	Chip-select access time		25		17		15	ns
TELQX	$\overline{CS}$ low to low Z(1)	5		5		5		ns
TEHQZ	$\overline{CS}$ high to high Z(1)		10		7		6	ns
TGLQV	Output Enable access time		12		8		6	ns
TGLQX	$\overline{OE}$ low to low Z(1)	2		2		2		ns
TGHQZ	$\overline{OE}$ high to high Z (1)		10		6		5	ns

Notes: 1. Parameters guaranteed, not tested, with output loading 5 pF. (See “AC Test Loads Waveforms” on page 8.)
2. Timings figures applicable for 8-bit, 16-bit and 32-bit mode.

Figure 9. Read Cycle nb 1: Address Controlled ($\overline{CS}$ = $\overline{OE}$ = V_{IL}, $\overline{WE}$ = V_{IH})

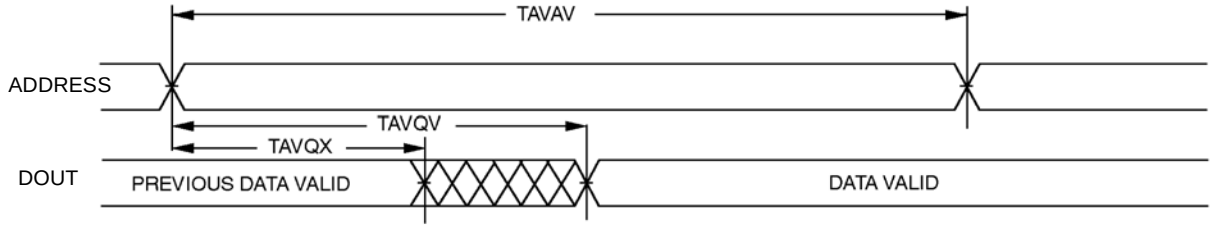
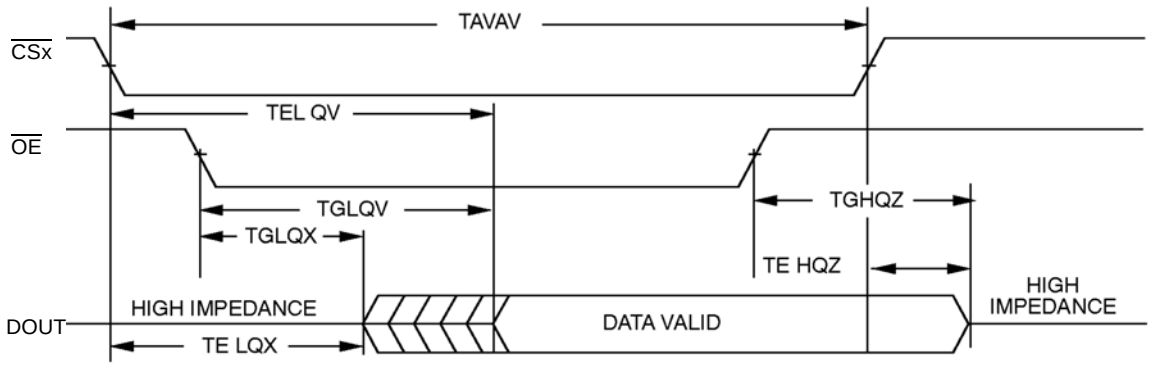


Figure 10. Read Cycle nb 2: Chip Select Controlled ($\overline{WE}$ = V_{IH})



Typical Applications

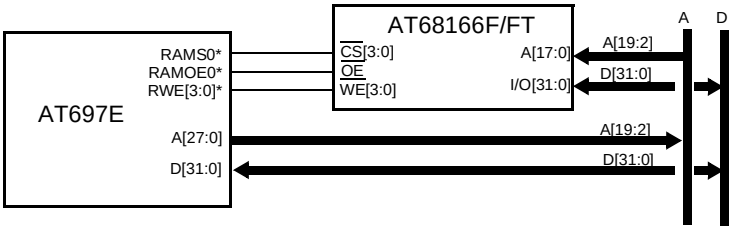
This section presents some standard implementations of the AT68166F/FT in application.

32-bit mode application

When used on a 32-bit (word) application, the module shall be connected as follow :

- The 32 lines of data are connected to distinct data lines
- The four $\overline{CS}$x are connected together and linked to a single host $\overline{CS}$ output
- Each one of the four $\overline{WE}$x is connected to a dedicated $\overline{WE}$ line on the host to allow byte, half word and word format write.

Figure 11. 32-bit typical application (1 SRAM bank)

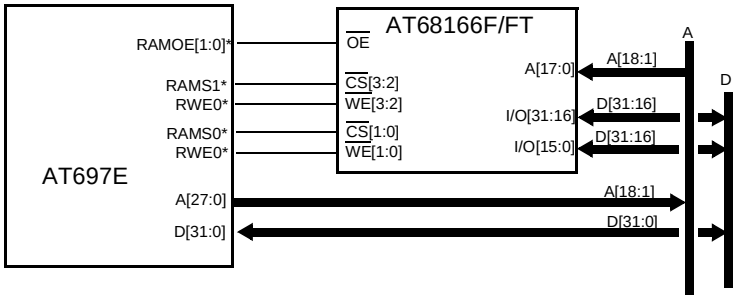


16-bit mode application

When used on a 16-bit (half word) application, the module can be connected as presented in the following figure. This allows use of a single AT68166F/FT part for two SRAM memory banks.

All input controls of the AT68166F/FT not used in the application shall be pulled-up.

Figure 12. 16-bit typical application (two SRAM banks)

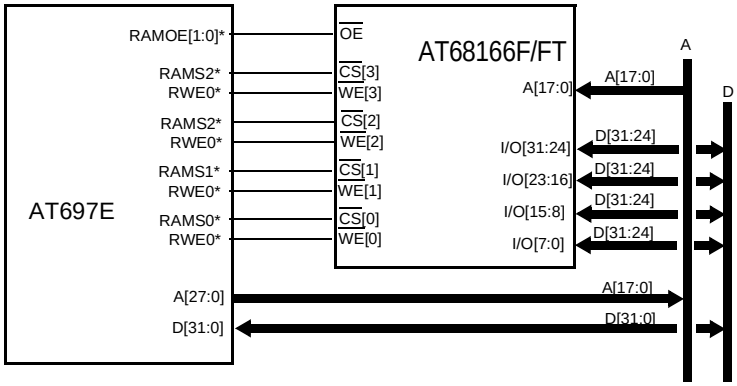


8-bit mode application

When used on a 8-bit (byte) application, the module can be connected as presented in the following figure. This allows use of a single AT68166F/FT part for up to four SRAM memory banks.

All input controls of the AT68166F/FT not used in the application shall be pulled-up.

Figure 13. 8-bit typical application (two SRAM banks)

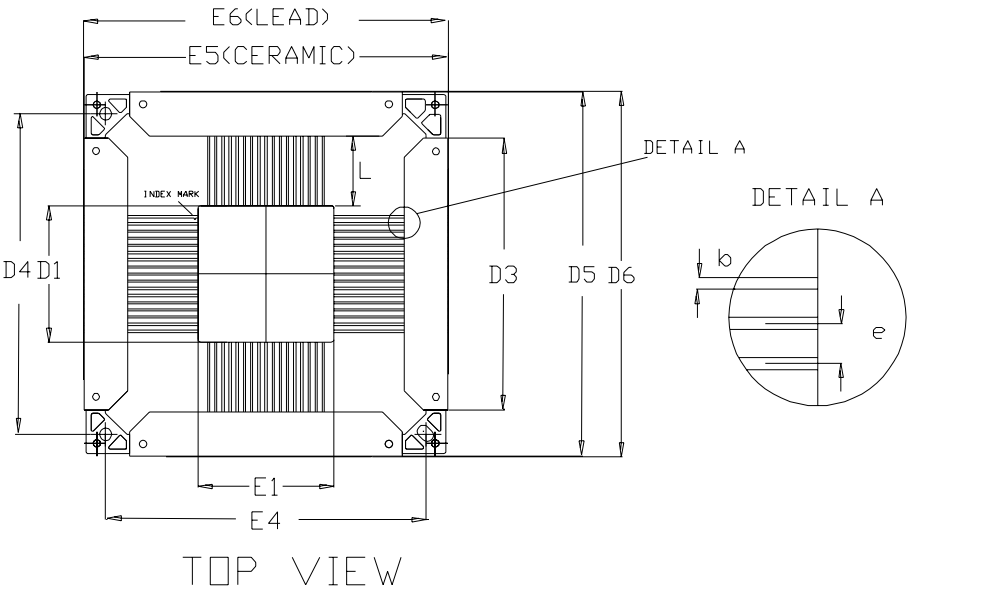


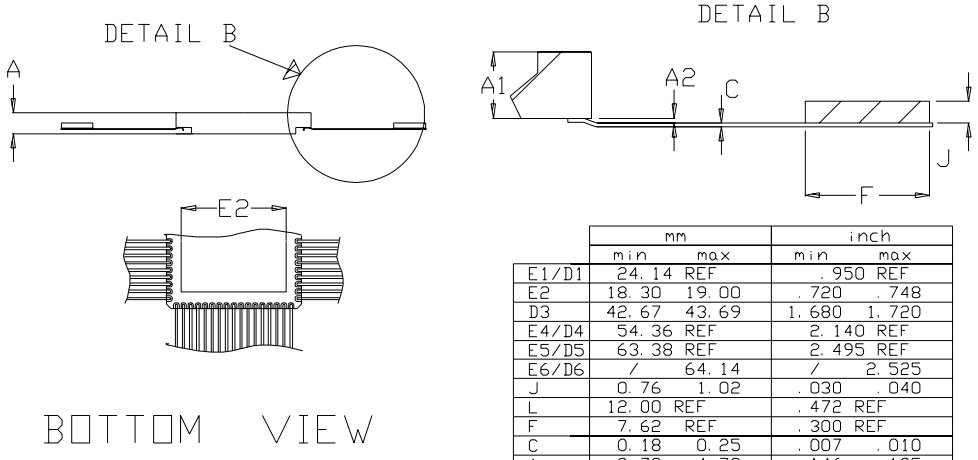
Ordering Information

Part Number	Temperature Range	Speed	Package	Flow
AT68166FT				
AT68166FT-YM25-E	25°C	25 ns/5V tol.	MQFPT68L	Engineering Samples
AT68166FT-YM25MQ	-55° to +125°C	25 ns/5V tol.	MQFPT68L	QML Q
AT68166FT-YM25SV	-55° to +125°C	25 ns/5V tol.	MQFPT68L	QML V
AT68166FT-YM25ESCC	-55° to +125°C	25 ns/5V tol.	MQFPT68L	ESCC
AT68166FT-YM17-E	25°C	17 ns/5V tol.	MQFPT68L	Engineering Samples
AT68166F				
AT68166F-YM15-E	25°C	15 ns/3.3V	MQFPT68L	Engineering Samples

Package Drawings

68-lead Quad Flat Pack (950 Mils) with non conductive tie bar





	mm		inch	
	min	max	min	max
E1/D1	24.14 REF		.950 REF	
E2	18.30	19.00	.720	.748
D3	42.67	43.69	1.680	1.720
E4/D4	54.36 REF		2.140 REF	
E5/D5	63.38 REF		2.495 REF	
E6/D6	/	64.14	/	2.525
J	0.76	1.02	.030	.040
L	12.00 REF		.472 REF	
F	7.62 REF		.300 REF	
C	0.18	0.25	.007	.010
A	3.72	4.70	.146	.185
A1	2.72	3.41	.107	.134
A2	0.20 BSC		.008 BSC	
e	1.27 BSC		.050 BSC	
b	0.33	0.43	.013	.017

Note: Lid is connected to Ground.

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